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# Up Your Average Cost Curve: Inefficient Entry and the New Protectionism

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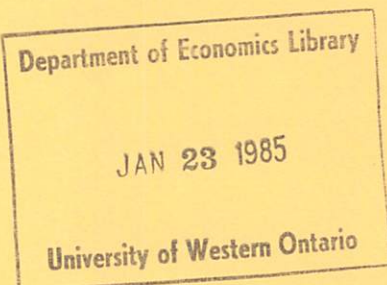
UP YOUR AVERAGE COST CURVE:

INEFFICIENT ENTRY AND THE NEW PROTECTIONISM

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and

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This paper contains preliminary findings from research work still in progress and should not be quoted without prior approval of the author.

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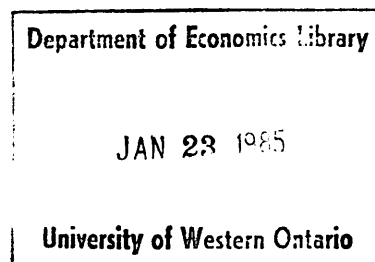
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Abstract

A two-country model is developed in which each country produces one good with increasing returns, the goods being perfect or imperfect substitutes. With Cournot-Nash behavior and free entry, certain restrictive trade policies have effects opposite to their favorable effects under no-entry assumptions. Import tariffs and export subsidies lead to inefficient entry that raises rather than decreases the average production cost of and price charged by the domestic industry with negative welfare consequences. We argue that these predictions of our model are closely consistent with extensive Canadian data on entry, exit, and firms' responses to trade liberalization.

November, 1984



## 1. Introduction

The observation of two-way trade in similar goods among the advanced economies has led trade economists to construct models based on increasing returns to scale (IRS) and imperfect competition (IC). Parallel research from a normative point of view has investigated the question of optimal commercial policy when either or both elements are present. The latter research has attracted wide attention insofar as it sheds light on the "new protectionism" under which governments act as agents in support of domestic corporations in the international marketplace.

Several widely-quoted results have emerged in the normative literature. Because of the deviation from marginal-cost pricing that must accompany IRS/IC, there is a possible role for the domestic government to use import tariffs or export subsidies to stimulate the output of domestic firms [Krugman (1984), Brander and Spencer (1984a), Dixit (1984), Venables (1985)]. This result is particularly strong for Cournot oligopolies but can fail for other conjectures [Eaton and Grossman (1983)]. A quite separate motivation for the tariff/subsidy policies comes from the existence of foreign imperfectly competitive firms. When these firms earn positive rents, a domestic tariff may transfer some of the rent to domestic citizens and firms [Brander and Spencer (1981, 1984b), Eaton and Grossman (1983), Dixit (1984)]. In these papers, a valid argument for an import tariff/export subsidy thus relies on: (A) the existence of foreign monopoly rents; or on (B) the policies stimulating the outputs of individual domestic firms.

The purpose of this paper is to show that the case for an import tariff/export subsidy based on IRS/IC largely collapses when there is free entry of domestic and foreign firms and no price discrimination between markets. The

case for protection reverts, at best, to the usual terms-of-trade argument under reasonable assumptions. An export subsidy or a production subsidy is never optimal under the same assumptions.

The model is a two-country model in which each country produces one good with IRS. The goods may but need not be perfect substitutes. Firms have U-shaped average cost functions. In order to provide a consistent comparison with the earlier papers just mentioned, income effects in demand are assumed away, and firms are assumed to play a Cournot game [again, see Eaton and Grossman (1983) for non-Cournot conjectures]. Similarly, a one-factor model is used in which considerations having to do with factor prices and endowments are assumed away.

Contrary to the results of the no-entry oligopoly literature and the segmented-markets model of Venables (1985), either a production subsidy or an export subsidy has a negative effect on output per firm in the domestic industry.<sup>1</sup> While total domestic output expands, possible welfare gains are dissipated by inefficient entry. The average cost of production or the gap between price and marginal cost increases, leading to a welfare effect opposite to that of the no-entry case. It is, of course, also true that there are no rents to transfer from foreign firms because they don't earn any. The case of an import tariff is more complicated, but for a wide range of functional forms, inefficient entry and rising or constant average cost is also the outcome. A tariff or subsidy large enough to drive out (or prevent entry of) the foreign industry leaves welfare less than or equal to the free trade welfare level.

There does remain a terms-of-trade argument for an import tariff, but the algebra suggests that this tariff is likely to be smaller relative to the CRS case and especially relative to the no-entry oligopoly case. When the domestic and foreign goods are identical, free trade is in fact optimal in our model. Eaton and Grossman (1984) have complementary results undermining

the import tariff/export subsidy prescription when there is no entry, but firms have Bertrand or consistent conjectures. Combining the results of both papers, it appears that the case for protection rests on very special assumptions indeed.

The obvious question is how to evaluate the results of this model given the contradictory results of the papers referenced above. We would argue that our model is important for two reasons. First, there is a considerable body of evidence which tends to support the predictions of our model. A case in point is a comprehensive data set on the entry and exit of manufacturing firms in Canada between 1970 and 1979, a period during which average industrial tariffs fell by 30%.<sup>2</sup> Statistics show that 16% of manufacturing sales in 1979 were by post-1970 entrants. A full 30% of sales in 1970 were accounted for by firms that had exited by 1979 [Baldwin and Gorecke (1983a)]. The same authors also found that Canadian firms responded to trade liberalization by increasing plant size and the length of production runs or by exiting. Average Canadian plant size increased by 33% over the 1970-1979 period of trade liberalization. Rationalization was particularly strong in industries with initially high tariffs and minimum efficient scales of production that were large relative to the Canadian market [Baldwin and Gorecki (1983b)]. This strong evidence of both exit of firms and a positive output response of those remaining Canadian firms to trade liberalization is closely consistent with the predictions of our model.

The second reason we believe this model is important relates to current public policy debates over the issue of active government support for "high tech" and other industrial exports. To date, the formal models constructed by international economists and referenced above can do nothing but add support to pro-subsidy arguments. Although the various authors have been careful to qualify the implications of their results for public policy, they clearly point in the direction of export promotion. If nothing else, our paper points out that these conclusions are not robust and that in a sensible, empirically-relevant alternative formulation the policy conclusions are reversed.

## 2. A Simple Linear Model

In this section, we present a model with linear demand and constant marginal cost that is very similar to the formulations of Brander and Spencer (1981, 1984a,b) and Venables (1985). More general specifications are considered in the following section.

There are three goods (X, Y, and Z) produced from one factor of production (L) which is in inelastic supply in each of two countries (home and foreign, with foreign variables denoted by an \* superscript). Z is produced in each country with constant returns by a competitive industry and serves as numeraire. Units are chosen so that  $Z = L_z$  and thus the wage rate also equals one. X and Y are produced with increasing returns by imperfectly competitive firms. For simplicity, domestic firms produce only X and foreign firms produce only Y, and X and Y may or may not be perfect substitutes. We have found that nothing but extra algebra is added by having all firms produce distinct products. Using lower-case c's to denote consumption per capita, individual consumers in both countries have the identical utility functions

$$(1) \quad U = u(c_x) + u(c_y) - \gamma c_x c_y + c_z; \quad u(c) = \alpha c - (\beta/2)c^2, \quad \beta \geq \gamma;$$

and where  $c_x = X/(L + L^*)$  in a free-trade equilibrium.  $c_y$  and  $c_z$  are similarly defined. The marginal utility of income in terms of  $c_z$  is constant, and inverse demand curves with prices in terms of  $c_z$  are given by

$$(2) \quad p_i = u' - \gamma c_j = \alpha - \beta c_i - \gamma c_j; \quad (i,j) = (x,y),$$

where  $\beta = \gamma$  is the case of perfect substitutes.

Let the outputs of individual firms in the X and Y industries be denoted by  $x$  and  $y$ , respectively, with  $n_x$  and  $n_y$  denoting the number of identical firms in these industries. A fixed cost plus constant marginal cost assumption is made about technology in the X and Y industries. Total cost ( $C_i$ ), average cost ( $AC_i$ ) and the slope of the average cost curve ( $AC'_i$ ) for firms are given by

$$(3) \quad C_x = m_x x + F_x; \quad AC_x = m_x + F_x/x; \quad AC'_x = -F_x/x^2.$$

$$(4) \quad C_y = m_y y + F_y; \quad AC_y = m_y + F_y/y; \quad AC'_y = -F_y/y^2.$$

Each firm behaves in a Cournot-Nash fashion, viewing the outputs of all other X and Y firms as fixed. In a free-trade equilibrium where  $c_x = n_x x/(L+L^*)$  and  $c_y = n_y y/(L+L^*)$ , the slope of the perceived demand curves facing X and Y firms is given by

$$(5) \quad p'_x = p'_y = -\beta/(L+L^*).$$

There are three equilibrium conditions for our economy. For the X industry, these are



- (6) Symmetry  $X = n_x x.$
- (7) Zero-Profits  $p_x = AC_x \Rightarrow \alpha - \beta c_x - \gamma c_y = m_x + F_x/x.$
- (8) Cournot Profit Max.  $p'_x = AC'_x \Rightarrow -\beta/(L+L^*) = -F_x/x^2$

Three corresponding equations apply to the Y industry. Symmetry means that all firms are identical, while free-entry results in zero profits (discreteness problems are ignored). In Cournot equilibrium with zero profits, a firm's average cost curve is tangent to its perceived demand curve (equation (8)). This condition is analytically convenient and is equivalent to the usual marginal revenue equals marginal cost conditions given zero profits.

Equation (8) and its counterpart for y can be solved directly to yield outputs per firm.

$$(9) \quad x = \left[ \frac{F_x (L+L^*)}{\beta} \right]^{\frac{1}{2}} ; \quad y = \left[ \frac{F_y (L+L^*)}{\beta} \right]^{\frac{1}{2}}$$

Outputs per firm at the free trade equilibrium exceed the outputs in autarky (or the industry is driven out as discussed below) due to the expansion in the size of the market.<sup>3</sup> This satisfies the condition for unambiguous gains from trade derived in Markusen and Melvin (1981, 1984), Helpman (1983), and Markusen (1981).<sup>4</sup>

Although the number of firms in each industry is of no particular welfare significance, they can be found by substituting (9) into (7), recalling that  $c_x = n_x x / (L+L^*)$  and  $c_y = n_y y / (L+L^*)$ .

$$(10) \quad n_x = (\alpha - m_x) \left( \frac{L+L^*}{\beta F_x} \right)^{\frac{1}{2}} - 1 - \left( \frac{\gamma}{\beta} \right) \left( \frac{F_y}{F_x} \right)^{\frac{1}{2}} n_y$$

$$(11) \quad n_y = (\alpha - m_y) \left( \frac{(L+L^*)}{\beta F_y} \right)^{\frac{1}{\beta}} - 1 - \left( \frac{\gamma}{\beta} \right) \left( \frac{F_x}{F_y} \right)^{\frac{1}{\beta}} n_x$$

Equations (10) and (11) can be solved to show that the total number of firms  $(n_x + n_y)$  will fall in free trade relative to autarky provided that X and Y are "good" substitutes. These equations can also be used to illustrate the important case of perfect substitutes  $(\gamma = \beta)$  since this will be of interest in the tariff analysis. With  $\gamma = \beta$ , equations (10) and (11) are linearly dependent and either have a continuum of solutions or no solution. If the cost functions are identical, the former occurs, indicating that it makes no difference where firms are located. If one country has a cost disadvantage in either F or m, that country's firms will be driven out.

Now we turn to the issue of tariffs and subsidies, and first assume that the home country places an import tariff on Y, denoted T. Price relationships are given as follows.

$$(12) \quad p_x = p_x^* \quad \Rightarrow \quad \alpha - \beta c_x - \gamma c_y = \alpha - \beta c_x^* - \gamma c_y^*$$

$$(13) \quad p_y = p_y^*(1+T) \quad \Rightarrow \quad (1+T)^{-1}(\alpha - \beta c_y - \gamma c_x) = \alpha - \beta c_y^* - \gamma c_x^*$$

If a firm produces one more unit of X, it must be divided between the two markets so as to preserve (12). This requires that incremental outputs  $d(x+x^*)$  be divided according to

$$(14) \quad dx = \delta d(x+x^*), \quad dx^* = (1-\delta)d(x+x^*); \quad \delta \equiv \frac{L}{L+L^*}$$

Using (14), the equilibrium price common to the two markets could be written as

$$(15) \quad p = (\alpha - \beta c_x - \gamma c_y) \delta + (\alpha - \beta c_x^* - \gamma c_y^*) (1-\delta)$$

Referring back to (2) and (3), the Cournot equilibrium condition in (8) becomes

$$(16) \quad -\beta(L+L^*)^{-1}\delta - \beta(L+L^*)^{-1}(1-\delta) = -F_x \delta/x^2 - F_x(1-\delta)/x^2$$

which is the same as (8). The home country tariff does not change output per firm in the X industry and therefore affects neither the average cost of production nor the price of X. Expansion of the X industry is accomplished entirely through entry.

A similar procedure is followed for Y. To preserve (13), incremental output  $d(y+y^*)$  must be divided between the two markets according to

$$(17) \quad dy = \sigma d(y+y^*), \quad dy^* = (1-\sigma)d(y+y^*); \quad \sigma \equiv \frac{(1+T)L}{(1+T)L+L^*}$$

Using (13) and (17), the foreign country price of  $Y(p_y^*)$  could be written as

$$(18) \quad p_y^* = (1+T)^{-1}(\alpha - \beta c_y - \gamma c_x)\sigma + (\alpha - \beta c_y^* - \gamma c_x^*)(1-\sigma)$$

The Y-industry equivalent of (16) is then

$$(19) \quad -(1+T)^{-1}\beta(L+L^*)^{-1}\sigma - \beta(L+L^*)^{-1}(1-\sigma) = -F_y \sigma/y^2 - F_y(1-\sigma)/y^2$$

Using the definition of  $\sigma$  in (17), equation (19) yields the equilibrium output per firm in the Y industry.

$$(20) \quad y = \left[ \frac{F_y((1+T)L+L^*)^{\frac{1}{2}}}{\beta} \right] > \left[ \frac{F_y(L+L^*)^{\frac{1}{2}}}{\beta} \right]$$

where the right-hand side of (20) is the free-trade level of  $y$  given in (9).

The home country tariff thus forces a rationalization in the Y industry:

output per firm rises and  $p_y^* = AC_y$  falls. The home country price  $p_y$  must rise, since

$$(21) \quad p_y = (1+T)AC_y = (1+T)m_y + (1+T)F_y \left[ \frac{(L^* + (1+T)L)F_y}{\beta} \right]^{-\frac{1}{2}}$$

These results are summarized as follows:

$$(22) \quad \text{Home Country Tariff: } p_y = p_y^*(1+T)$$

$$\frac{dp_x}{dT} = \frac{dp_x^*}{dT} = 0, \quad \frac{dp_y}{dT} > 0, \quad \frac{dp_y^*}{dT} < 0.$$

Now observe that the price relationship  $p_y = p_y^*(1+T)$  generated by the home country tariff would also be generated by a foreign export tax  $T$  on  $Y$ . Such an export tax would give us the results in (22). A home country export tax on  $X$  would then be summarized as follows:

$$(23) \quad \text{Home Country Export Tax: } p_x^* = p_x(1+T)$$

$$\frac{dp_x}{dT} < 0, \quad \frac{dp_x^*}{dT} > 0, \quad \frac{dp_y}{dT} = \frac{dp_y^*}{dT} = 0$$

To get the effects of a home country export subsidy, we then simply allow  $T < 0$ . An increase in the tax rate is thus  $dT < 0$ .

Combining (22) and (23), we see that an import tariff or an export tax has the usual favorable terms-of-trade effect. The former forces down the foreign price of  $Y$  while the latter forces up the foreign price of  $X$ . The import tariff has no rationalizing effect on the  $X$  industry, an important difference from the no-entry oligopoly model and the segmented markets model of Venables (1985). Thus the beneficial effect of a small tariff is simply the usual terms-of-trade effect. The export tax does however confer the added benefit of increasing output per firm (reducing average cost) in the  $X$  industry. An export subsidy on  $X$  would, conversely, be unambiguously bad: (A) the foreign price of  $X$  would fall; (B) domestic average cost and price of  $X$  would rise; and (C) the price of  $Y$  would remain unchanged.

Two final points should be mentioned. First, it can be shown that either an import tariff or an export subsidy will cause  $n_x$  to rise and  $n_y$  to fall, and conversely for an export tax. Since the number of firms is of no particular welfare significance, this will not be pursued. Second, if X and Y are perfect substitutes, any arbitrarily small import tariff on Y or export subsidy on X drives out the Y industry. Correspondingly, an export tax on X drives out X.

Results for production subsidies are easier to obtain because the price of each good is equalized between countries. Refer to the X industry equilibrium conditions in equations (7) and (8) above. For a specific output subsidy  $S$ , we can merely subtract  $S$  from the right-hand side of equation (7). But this had no effect on the Cournot equilibrium condition (8), hence the subsidy has no effect on output per firm and average cost. There is similarly no effect on  $y$ . The subsidy simply results in entry into the X industry, exit from the Y industry, and a fall in  $p_x = p_x^*$ .

$$(24) \quad \text{Home Country Specific Subsidy: } p_x = p_x^* = AC_x - S$$

$$\frac{dp_x}{dS} = \frac{dp_x^*}{dS} = -1, \quad \frac{dp_y}{dS} = \frac{dp_y^*}{dS} = 0$$

An advalorem subsidy would on the other hand, multiply total cost and therefore marginal and average cost by  $(1-S)$ . Using (7) and (8), we will see that output per firm will fall to

$$(25) \quad x = \left[ \frac{F(L+L^*)(1-S)}{\beta} \right]^{\frac{1}{2}}$$

while output per firm in the Y industry is unaffected.  $AC_x$  rises with the subsidy, and hence  $p_x = p_x^*$  falls by proportionately less than the subsidy.

(26) Home Country Advalorem Subsidy:  $p_x = p_x^* = AC_x(1-S)$

$$0 > \frac{dp_x}{p_x} = \frac{dp_x^*}{p_x^*} > -\frac{dS}{(1-S)}, \quad \frac{dp_y}{dS} = \frac{dp_y^*}{dS} = 0.$$

Note finally that a "capital cost" subsidy on F has the same effect and, for an advalorem capital subsidy we again have equation (25).

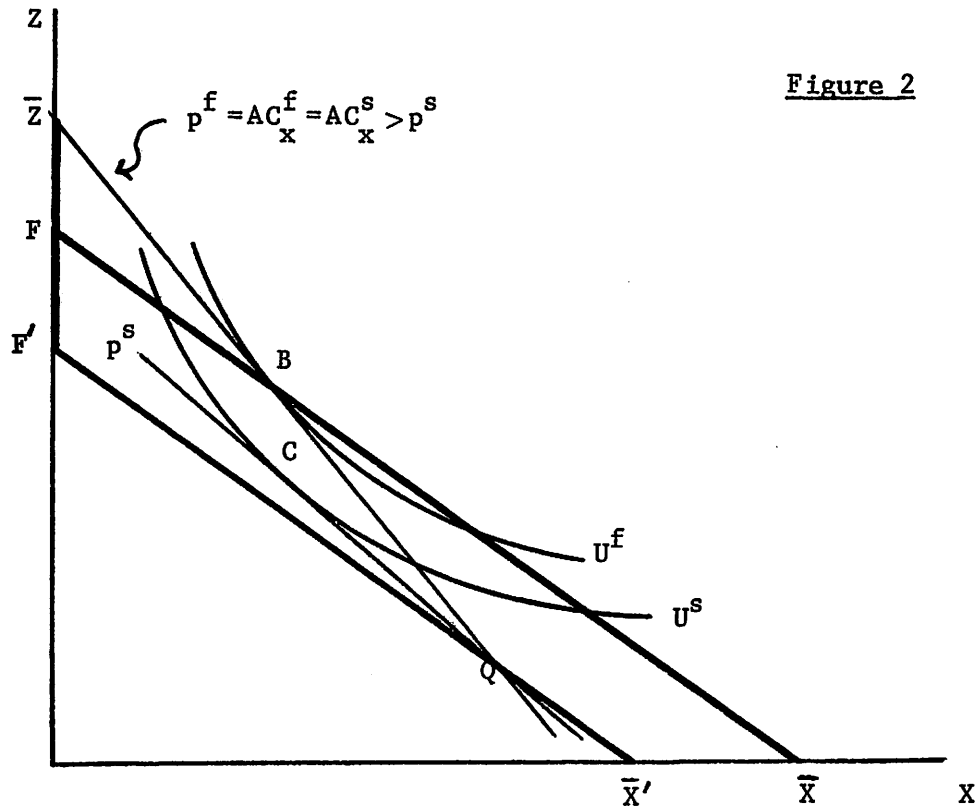
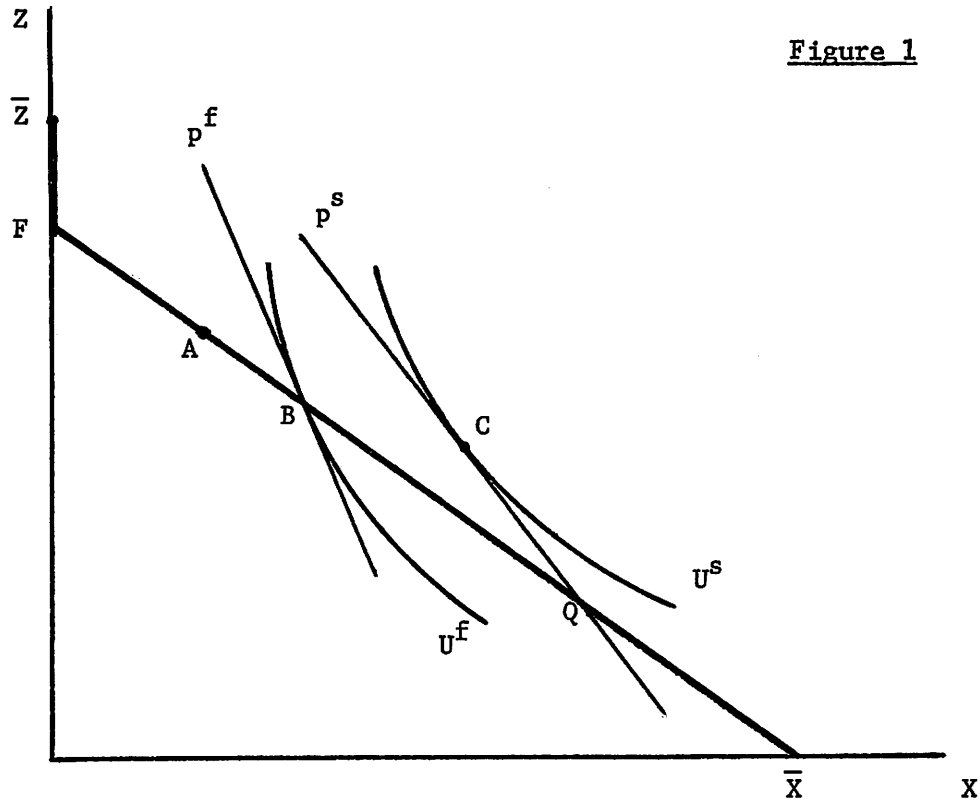
(27) Home Country Capital Subsidy:  $p_x = p_x^* = m + F(1-S)/x$

$$0 > \frac{dp_x}{p_x} = \frac{dp_x^*}{p_x^*} > -\frac{dS}{(1-S)}, \quad \frac{dp_y}{dS} = \frac{dp_y^*}{dS} = 0$$

This last subsidy is reminiscent of the capital subsidy analyzed by Spencer and Brander (1983).

Combining these three results with our result on the export subsidy, we see that all four subsidies lead to inefficient entry, increased or at best constant average cost, and a deterioration of the domestic terms of trade. Figures 1 and 2 contrast our results with those that are obtained from a no-entry oligopoly model for the case of a specific output subsidy. With only one firm producing X, Figure 1 gives the production frontier as  $\overline{ZFX}$  where  $\overline{ZF}$  is the fixed cost F and the slope of  $\overline{FX}$  is the constant marginal cost  $m_x$ . Suppose that the foreign country is absolutely identical and that X and Y are homogeneous products. Each country has a single firm producing this good. Markusen (1981) showed that with Cournot behavior the ability to trade will generate a pro-competitive effect (demand is perceived to be more elastic) although no trade need take place.

The free-trade equilibrium could be at a point like B in Figure 1 with a price ratio  $p^f$ . The price ratio exceeds the marginal cost of production as shown, but the pro-competitive effect generates a welfare improvement over the



autarky equilibrium depicted by A. In this situation, a small production subsidy to X has a beneficial effect, shifting production to Q and consumption to C in Figure 1. The country exports X and welfare improves despite the fall in  $p$  to  $p^S$ . The welfare gain shown in Figure 1 results from the fact that the output of the domestic firm is stimulated, with the economy capturing the surplus of price minus marginal cost on the incremental output.

Figure 2 shows the same subsidy with free entry.  $\bar{ZF}$  now equals the sum of the fixed costs of the firms existing in free trade. Point B gives the free-trade equilibrium point where once again no trade actually takes place. The average cost of producing X is given by

$$(28) \quad AC_x = L_x/X = (\bar{L}-L_z)/X = (\bar{Z}-Z)/X$$

which is just the slope of the line connecting  $\bar{Z}$  and B in Figure 2. This slope is thus also the price ratio  $p^f$  as shown.

A specific output subsidy does not change the output of individual firms but does induce entry as shown above. Additional fixed costs are invested and the production frontier becomes  $\bar{ZF}'\bar{X}'$  in Figure 2. The average cost of production does not change so that the new production point is Q. But the consumer price ratio has fallen ( $p^S < AC_x^S$ ) and is depicted by  $p^S$  in Figure 2. The country exports X to arrive at consumption point C which is unambiguously inferior to B. The subsidy deteriorates the terms of trade without producing a favorable effect on the output per firm in the X industry. The export and advalorem subsidies are even worse since they have the added effect of raising the average cost of X.



### 3. A General Analysis of the Free-Entry Equilibrium with Trade

In order to investigate the robustness of the above results and determine which assumptions are crucial to the analysis, a more general specification of the model in Section 2 is considered here. It generalizes that model by allowing for a wider range of admissible demand and cost functions. It will be shown that the important results for the linear case can be extended to considerably more general settings and that the linearity assumptions serve only to simplify the analysis.

As previously, it is assumed that the IRS sector consists of two goods X and Y which may or may not be perfect substitutes. Home and foreign country demands are represented by the inverse demand functions

$$(29a) \quad p_x = g(X, Y)$$

$$(29b) \quad p_x^* = g\left(\frac{X^*}{\lambda}, \frac{Y^*}{\lambda}\right)$$

$$(30a) \quad p_y = h(X, Y)$$

$$(30b) \quad p_y^* = h\left(\frac{X^*}{\lambda}, \frac{Y^*}{\lambda}\right)$$

where  $\lambda > 0$  captures differences in the relative sizes of the two countries.

It is assumed that  $g_x = \frac{\partial p_x}{\partial X} < 0$ ,  $g_y = \frac{\partial p_x}{\partial Y} < 0$ ,  $h_x = \frac{\partial p_y}{\partial X} < 0$ ,  $h_y = \frac{\partial p_y}{\partial Y} < 0$ ;

and that  $|g_x| \geq |g_y|$ ,  $|h_y| \geq |h_x|$  with strict equality holding only if X and Y are perfect substitutes. Finally both  $g(\cdot)$  and  $h(\cdot)$  are assumed strictly concave.<sup>5</sup>

Firms in each country have access to an identical technology defined by the average cost function  $AC(\cdot)$ , with  $AC(x)$  defining average cost to an individual X-producing firm of producing x units of output.  $AC(y)$  is defined analogously. The average cost curve is assumed to be U-shaped such that  $AC'(x) \leq 0$  for all  $x \leq \tilde{x}$  and  $AC''(x) > 0$  for all x (similarly for y). It is also assumed that the demand and cost functions are such that only a finite number of firms may profitably exist in any equilibrium.<sup>6</sup> As before, any problem with this number not being an integer is ignored.

Equilibrium is as defined previously with (6)-(8) determining a set of equilibrium points  $(n_x, x)$ ,  $(n_y, y)$ . For present purposes, the autarky equilibrium point will be represented by the points  $(\underline{n}_x, \underline{x})$ ,  $(\underline{n}_y^*, \underline{y}^*)$  yielding market output  $\underline{X} = \underline{n}_x \underline{x}$ ,  $\underline{Y}^* = \underline{n}_y^* \underline{y}^*$  and market prices  $p_x = g(\underline{X}, 0)$ ,  $p_y^* = h(0, \underline{Y}^*/\lambda)$ .<sup>7</sup>

If the home and foreign countries move from a position of autarky to free trade, then, since price discrimination is not possible, prices of X must be equalized across countries, as must prices of Y. This implies that, with free trade, demand can be represented by the system

$$(31) \quad p_x = G(Q_x, Q_y)$$

$$(32) \quad p_y = H(Q_x, Q_y)$$

where  $Q_x \equiv X + X^*$  and  $Q_y \equiv Y + Y^*$ . The properties of (31) and (32) are defined by the assumption on the system (29)-(30). Thus, for instance,  $G(\cdot)$  and  $H(\cdot)$  are both concave with  $G_x = \frac{\partial p_x}{\partial Q_x} < 0$ ,  $G_y = \frac{\partial p_x}{\partial Q_y} < 0$  and similarly for  $H_x$  and  $H_y$ . The free trade equilibrium point is given by  $(\bar{n}_x, \bar{x})$ ,  $(\bar{n}_y, \bar{y})$  with market output  $\bar{Q}_x = \bar{n}_x \bar{x}$ ,  $\bar{Q}_y = \bar{n}_y \bar{y}$  and market price  $\bar{p}_x = G(\bar{Q}_x, \bar{Q}_y)$ ,  $\bar{p}_y = H(\bar{Q}_x, \bar{Q}_y)$

Of initial interest is the effect of free trade on the equilibrium allocations, particularly of  $x$  and  $y$ . If X and Y are imperfect substitutes, then it is possible to show the following:

**Proposition 1:** If X and Y are imperfect substitutes and  $G_{xy} = H_{yx} \equiv 0$ , then  $\bar{x} > \underline{x}$ ,  $\bar{y} > \underline{y}^*$ .

**Proof:** Suppose not. Then there are essentially two cases.

**Case I:**  $\bar{x} \leq \underline{x}$ ,  $\bar{y} \leq \underline{y}^*$

From the structure of demand, it must be that  $G((1+\lambda)\underline{n}_x \underline{x}, 0) = g(\underline{n}_x \underline{x}, 0) = AC(x)$  and  $G_x((1+\lambda)\underline{n}_x \underline{x}, 0) = \frac{1}{1+\lambda} g_x(\underline{n}_x \underline{x}, 0) > g_x(\underline{n}_x \underline{x}, 0)$ . Further, since  $Q_y > 0$ ,

condition (7) requires that, if  $\bar{x} \leq \underline{x}$ , then  $\bar{n}_x \bar{x} < (1+\lambda)\underline{n}_x \underline{x}$ . Concavity of  $G(\cdot)$  and the fact that  $G_{xy} \equiv 0$  imply that  $G_x(n_x \underline{x}, n_y \underline{y}) > \frac{1}{1+\lambda} g_x(\underline{n}_x \underline{x}, 0) \forall x \leq \underline{x}$ ,  $\underline{n}_x \underline{x} < (1+\lambda)\underline{n}_x \underline{x}$ . Since  $g_x(\underline{n}_x \underline{x}, 0) \geq AC'(x) \forall x \leq \underline{x}$ , this implies that  $G_x(n_x \underline{x}, n_y \underline{y}) > AC'(x) \forall x \leq \underline{x}$  and  $\underline{n}_x$  such that (7) is satisfied. This, though violates (8) and so  $\bar{x} \leq \underline{x}$ ,  $\bar{y} \leq \underline{y}^*$  cannot be an equilibrium.

Case II:  $\bar{x} \leq \underline{x}$ ,  $\bar{y} > \underline{y}^*$

Since the above holds for any  $Q_y$ , the same results go through and the same contradiction results. Obviously, the case  $\bar{x} > \underline{x}$ ,  $\bar{y} \leq \underline{y}^*$  could be dealt with analogously. Thus, the only possible equilibrium involves  $\bar{x} > \underline{x}$ ,  $\bar{y} > \underline{y}^*$ .

□

It should be noted that, in addition to the conditions that

$G_{xy} = H_{xy} \equiv 0$ , the above result only exploits two other demand properties:

i) that  $G_{xx} < 0$  and  $H_{yy} < 0$ ; and ii) that  $G_y < 0$ ,  $H_x < 0$ . Further, the result holds for any arbitrary U-shaped average cost curve. Therefore, if under free trade, demand can be represented as

$$(33) \quad p_x = B(Q_x) + M(Q_y)$$

$$(34) \quad p_y = D(Q_x) + N(Q_y)$$

where only  $B(\cdot)$  and  $N(\cdot)$  are concave, while  $M'$  and  $D' < 0$ , then free trade results in the rationalization of production in both countries. In addition, since  $\bar{x} > \underline{x}$ ,  $\bar{y} > \underline{y}^*$ , (7) implies that free trade causes both  $p_x$  and  $p_y$  to fall.

If  $G_{xy}$ ,  $H_{xy} \neq 0$ , then, with some additional structure on demand, similar results concerning the impact of free trade can be derived. The requisite structure is a demand symmetry restriction which requires  $\lambda = 1$  and the system (29)-(30) to be such that

$$(35) \quad \text{Demand Symmetry: For } Y = X^* \quad h(X^*, Y^*) = g(X, Y) \Leftrightarrow X = Y^*$$

$$\text{For } X = Y^* \quad h(X^*, Y^*) = g(X, Y) \Leftrightarrow Y = X^*$$

If (35) is imposed, then (6)-(8) will define a fully symmetric equilibrium (FSE) in which  $n_x = n_y$  and  $x = y$ . If an autarky FSE is compared to a free trade FSE, then the following can be proved.

Proposition 2: If  $X$  and  $Y$  are imperfect substitutes,  $G_{xy}, H_{xy} > 0$  and  $|G_{xx}| > |G_{xy}|$ ,  $|H_{yy}| > |H_{yx}|$ , then  $\bar{x} = \bar{y} > \underline{x} = \underline{y}^*$ .

Proof: Suppose not. Then either  $\bar{x} = \bar{y} = \underline{x} = \underline{y}^*$  or  $\bar{x} = \bar{y} < \underline{x} = \underline{y}^*$ . In the former case, since  $G_{xy} > 0$ ,  $G_{xx} < 0$ , it must be that  $G_x(n_x \bar{x}, n_y \bar{y}) > \frac{1}{2} G_x(n_x \underline{x}, 0) > AC'(\underline{x}) \quad \forall n_x < 2n_x, n_y \bar{y} > 0$ . From (7) if  $\bar{x} = \underline{x}$ , then it must be that  $\bar{n}_x < 2n_x$  and  $\bar{n}_y \bar{y} > 0$ . Therefore, at  $\bar{x} = \bar{y} = \underline{x} = \underline{y}^*$ ,  $G_x(\bar{n}_x \bar{x}, \bar{n}_y \bar{y}) > AC'(\bar{x})$  violating (8). So this cannot be an equilibrium.

For  $\bar{x} = \bar{y} < \underline{x} = \underline{y}^*$  define the path  $P(x=y, n_x=n_y)$  between the points  $(\bar{x}=\bar{y}, \bar{n}_x=\bar{n}_y)$  and  $(\underline{x}=\underline{y}^*, \bar{n}_x=\bar{n}_y)$  such that along  $P(\cdot)$ , (7) is fulfilled. Then, along this path  $dG_x(n_x x, n_x x)/dx = (G_{xx} + G_{xy})(n_x + x \frac{dn_x}{dx})$ . The first term in brackets is negative by assumption. The second is positive as long as  $Q_x$  increases as  $x = y$  increases. This must be the case along  $P(\cdot)$  since (7) requires  $p_x = p_y$  fall as  $x = y$  increases. Thus  $\frac{dG_x}{dx} < 0$  along  $P(\cdot)$ . Combined with the above result for  $\bar{x} = \bar{y} = \underline{x} = \underline{y}^*$ , this implies that  $G_x > AC'(x) \quad \forall x = y < \underline{x} = \underline{y}^*$ , and  $n_x = n_y$  such that (7) is satisfied. This violates (8), however. Therefore, it must be that  $\bar{x} = \bar{y} > \underline{x} = \underline{y}^*$ .

□

The demand restrictions imposed in the above Proposition are ones which might be imposed to guarantee stability of a Cournot duopoly. If these conditions are met, along with (35), then free trade results in both rationalization

of industry production and lower prices. Moreover, were  $G_{xy}, H_{xy} < 0$ , then a proof similar to the above could be used (without resort to the stability conditions) to show that identical results would hold. The only proviso would be that  $G_{xy}, H_{xy}$  are not sufficiently negative as to make  $H_y = G_x < AC'(x) = AC'(y)$  at the point  $x = y = \underline{x} = \underline{y}^*$ . Therefore, in the preceding section, were  $L = L^*$ , then neither the demand linearity nor cost assumptions would impose any additional structure necessary for obtaining the free trade result. The symmetry alone would be enough.

Finally, if X and Y are perfect substitutes, then, given the conditions on (29) and (30), no additional structure is needed to prove rationalization due to free trade. Since, with X and Y perfect substitutes,  $g(X, Y) = h(X, Y)$ ,  $g(\frac{X^*}{\lambda}, \frac{Y^*}{\lambda}) = h(\frac{X^*}{\lambda}, \frac{Y^*}{\lambda})$ , without loss of generality, let autarky demands be given by  $p_x = \phi(X)$ ,  $p_y^* = \phi(\frac{Y^*}{\lambda})$  and free trade demand by  $p = \bar{\phi}(X+Y^*)$ . Then it is easy to prove that:

**Proposition 3:** If X and Y are perfect substitutes,  $\bar{x} = \bar{y} > \max[\underline{x}, \underline{y}^*]$ .

**Proof:** Suppose not. Then w.l.o.g. let  $\underline{y}^* > \underline{x}$ . If  $\bar{x} = \bar{y} \leq \underline{y}^*$ , then, by (7)  $\bar{p} \geq p_y^*$ . At  $\bar{x} = \bar{y} = \underline{y}^*$ ,  $\bar{p} = p_y^*$  and  $(1+\lambda)\bar{\phi}' = \phi' = AC'(\underline{y}^*)$ . This implies that  $\bar{\phi}' - AC'(\underline{y}^*) > 0$  violating (8). Further since  $\bar{\phi}'' < 0$ ,  $AC'' > 0$ , (8) will be violated for any  $\bar{x} = \bar{y} < \underline{y}^*$ ,  $\bar{p} > p_y^*$ . Thus  $\bar{x} = \bar{y} > \underline{y}^*$ .

□

Therefore, with X and Y perfect substitutes rationalization again occurs with a resultant reduction in price. In addition, it is easy to see that the smaller country will rationalize production by a greater amount than the larger country.<sup>8</sup>

As regards the effect of trade on the equilibrium number of firms, given the ambiguity that arises in the linear example, it is not surprising that this

is a general result. To illustrate the nature of the problem, as well as to provide the one unambiguous result, consider the case in which X and Y are perfect substitutes and  $\lambda = 1$ . Further, define the free trade points  $n_q = n_x + n_y$  and  $q = x = y$ . Then, (7) defines a zero profit locus in  $(n_q, q)$  space. Further, both the free trade equilibrium point  $(\bar{n}_q = \bar{n}_x + \bar{n}_y, \bar{q} = \bar{x} = \bar{y})$  and the combined autarky point  $(n_q = \frac{n_x}{x} + \frac{n_y}{y}, q = x = y^*)$  lie on this locus. Differentiation shows that the slope of the zero profit locus is given by

$$(36) \quad \frac{dn_q}{dq} = \frac{1}{q} \left[ \frac{AC'}{\bar{\Phi}'} - n_q \right]$$

Since at the autarky point  $AC' / \bar{\Phi}' = 2$ ,  $\frac{dn_q}{dq} \leq 0$  there as long as each country can support at least a monopoly in autarky. Further, since  $\bar{\Phi}$  is concave,  $AC' / \bar{\Phi}'$  is decreasing in  $q$ ; and therefore  $\bar{n}_q < n_q$  as long as each country can support a monopoly in autarky.

The problem that arises in general is that once X and Y are imperfect substitutes the point  $(\frac{n_x}{x}, x)$ ,  $(\frac{n_y^*}{y^*}, y^*)$  does not have to be on the free trade zero profit locus. In particular, at the point  $(x, y^*)$  the number of firms must increase to drive profits to zero. The size of the increase depends on how close substitutes X and Y are. Thus, while rationalization of production leads to a decrease in  $n_x$  and  $n_y$  as above, it may not be sufficient to offset the increase in  $n_x$  and  $n_y$  due to the expansion of markets produced by free trade. On net, then, the number of firms may actually rise with free trade.

Just as with the autarky v. free-trade results, the subsidy/tariff results derived in the preceding section can also be extended to considerably more general settings. Consider, for instance, the case in which the home country provides X-producers with a specific production subsidy, S. With trade, demand is defined as in (31)-(32). Technology, however, is represented by

$$(37) \quad AC_x = AC(x) - S$$

$$(38) \quad AC_y = AC(y)$$

Relative to the free-trade (i.e.,  $S = 0$ ) equilibrium  $(\bar{n}_x, \bar{x}), (\bar{n}_y, \bar{y})$ , the subsidy equilibrium  $(n'_x, x'), (n'_y, y')$  will involve greater numbers of X-producers each producing less output. Therefore, as in the linear example, the subsidy induces inefficient entry into the X-industry. This result is formalized below.

**Proposition 4:** If  $G_{xy} = H_{yx} \equiv 0$ , then  $[Q'_x > \bar{Q}_x, Q'_y < \bar{Q}_y]$ ,  $x' < \bar{x}$ ,  $y' > \bar{y}$ ,  $n'_x > \bar{n}_x$ ,  $n'_y < \bar{n}_y$ ,  $p'_y < \bar{p}_y$ .

**Proof:** (i)  $[Q'_x > \bar{Q}_x, Q'_y < \bar{Q}_y]$ . Suppose not. Then three cases are possible.

If  $[Q'_x > \bar{Q}_x, Q'_y > \bar{Q}_y]$ , then  $p'_y < \bar{p}_y \Rightarrow$  from (7)  $y' > \bar{y}$ ; but by concavity  $H_y < AC'(y) \forall y \geq \bar{y}$  violating (8). If  $[Q'_x < \bar{Q}_x, Q'_y < \bar{Q}_y]$ , then  $p'_y > \bar{p}_y \Rightarrow$  from (7)  $y' < \bar{y}$ ; but, by concavity,  $H_y > AC'(y) \forall y < \bar{y}$  again violating (8). Finally, if  $[Q'_x < \bar{Q}_x, Q'_y > \bar{Q}_y]$ , then concavity requires that, if  $G_x = AC'(x), x' > \bar{x} \Rightarrow$  from (7)  $p'_x < \bar{p}_x$ ; and that, if  $H_y = AC'(y), y' < \bar{y} \Rightarrow$  from (7)  $p'_y > \bar{p}_y$ . This is clearly impossible. Therefore it must be that  $[Q'_x > \bar{Q}_x, Q'_y < \bar{Q}_y]$

(ii)  $x' < \bar{x}$ . This follows immediately from (8) and the concavity of  $G(\cdot)$ .

(iii)  $y' > \bar{y}$ . Immediate from (8) and the concavity of  $H(\cdot)$ .

(iv)  $n'_x > \bar{n}_x$ . This follows from (ii) and the fact that  $Q'_x > \bar{Q}_x$

(v)  $n'_y < \bar{n}_y$ . This follows from (iii) and the fact that  $Q'_y < \bar{Q}_y$ .

(vi)  $p'_y < \bar{p}_y$ . This follows from (iii) and (7).

□

Since  $p'_x = AC(x') - S$ ,  $p'_x$  may be greater or less than  $\bar{p}_x$  depending on the size of the reduction in  $x$ . In any event, the result (24) for the linear case continues to go through for any demand system of the form (33)-(34) and arbitrary U-shaped average cost curves.

The analysis for an ad valorem export subsidy, while somewhat more complex, provides similar confirmation of the results in Section 2. Consider the case in which  $X$  and  $Y$  are imperfect substitutes and the home country provides an ad valorem export subsidy,  $T$  (as before, the perfect substitute case is trivial). Then, in the neighborhood of free trade (i.e.,  $T = 0$ ), an increase in the export subsidy leaves demand for  $Y$  unchanged, being given by

$$(39) \quad p_y = H(Q_x, Q_y)$$

as before.<sup>9</sup> For  $X$ , home country demand is unchanged, but foreign demand is now of the form  $p_x^* = g(\frac{x^*}{\lambda}, \frac{y^*}{\lambda}) / (1-T)$ . Since  $p_x^* = p_x(1-T)$ , the effect of the subsidy can be represented by a producer price function of the form

$$(40) \quad p_x = \Gamma(Q_x, Q_y)$$

with  $\Gamma(Q_x, Q_y) > G(Q_x, Q_y) \quad \forall (Q_x, Q_y)$

$$\Gamma_x(Q_x, Q_y) < G_x(Q_x, Q_y) \quad \forall (Q_x, Q_y)$$

The subsidy equilibrium is defined by (6)-(8) above, with  $p_x$  defined by (40); and the subsidy equilibrium point is given, as before by  $(n'_x, x'), (n'_y, y')$ .

It should be clear from (40) that  $(\bar{n}_x, \bar{x})$ ,  $(\bar{n}_y, \bar{y})$  cannot be a subsidy equilibrium. In fact, a subsidy equilibrium may involve either  $Q'_x > \bar{Q}_x$  or  $Q'_x < \bar{Q}_x$ .<sup>10</sup> Specifically, it must be that



**Proposition 5:** If  $H_{xy} = \Gamma_{xy} \equiv 0$ , then either  $[Q'_x \geq \bar{Q}_x, Q'_y \leq \bar{Q}_y]$  or  $[Q'_x \leq \bar{Q}_x, Q'_y \geq \bar{Q}_y]$ .

**Proof:** Suppose not. Then there are two possible cases. If  $[Q'_x > \bar{Q}_x, Q'_y > \bar{Q}_y]$ , then  $p'_y < \bar{p}_y \Rightarrow$  from (7)  $y' > \bar{y}$ ; but, by concavity,  $H_y < AC'(y) \forall y > \bar{y}$ , violating (8). If  $[Q'_x < \bar{Q}_x, Q'_y < \bar{Q}_y]$ , then  $p'_y > \bar{p}_y \Rightarrow$  from (7),  $y' < \bar{y}$ ; but by concavity,  $H_y > AC'(y) \forall y < \bar{y}$ .

□

The intuition for this result is quite straightforward. The imposition of the subsidy causes the demand curve for X to rotate outward, leading to an increase in market output at any price. However, it also generates positive profits which lead to entry into the X-industry. Because of the decreasing cost assumption, this leads to an increase in industry average costs. Since, in equilibrium, industry profits must be zero, this induces increases in  $p_x$  with resultant reductions in  $Q_x$ . Whether, on net,  $Q_x$  rises or falls then depends on the relative shapes of the demand and average cost curves. That is, it depends on whether the price increases brought about by inefficient entry more than offset the demand increases induced by the subsidy.

Whether  $Q_x$  rises or falls, however, the effect of the subsidy on individual firm output is the same: it causes a reduction in  $x$  and resultant increases in  $p_x$ . This is formalized in the following two propositions.

**Proposition 6:** If  $H_{xy} = \Gamma_{xy} \equiv 0$  and  $[Q'_x > \bar{Q}_x, Q'_y < \bar{Q}_y]$ , then  $x' < \bar{x}$ ,  $y' > \bar{y}$ ,  $p'_x > \bar{p}_x$ ,  $p'_y < \bar{p}_y$ ,  $n'_x > \bar{n}_x$ ,  $n'_y < \bar{n}_y$ .

**Proof:** Since  $H_{xy} \equiv 0$ ,  $H_{yy} < 0$  and  $Q'_y < \bar{Q}_y$ , then  $H_y > AC'(y) \forall y < \bar{y}$ , violating (8). Therefore  $y' > \bar{y}$ . Similarly, since at  $Q_x = \bar{Q}_x$ ,  $\Gamma_x < G_x$ , while  $\Gamma_{xx} < 0$  and  $Q'_x > \bar{Q}_x$ ,  $\Gamma_x < AC'(x) \forall x \geq \bar{x}$ . Therefore  $x' < \bar{x}$ . The price results follow

from (7). That  $n'_x > \bar{n}_x$  follows from the fact that  $x' < \bar{x}$ ,  $Q'_x > \bar{Q}_x$ ; and  $n'_y < \bar{n}_y$  follows from  $y' > \bar{y}$ ,  $Q'_y < \bar{Q}_y$ .

□

Proposition 7: If  $H_{xy} = \Gamma_{xy} \equiv 0$  and  $[Q'_x < \bar{Q}_x, Q'_y > \bar{Q}_y]$ , then  $x' < \bar{x}$ ,  $y' < \bar{y}$ ,  $p'_x > \bar{p}_x$ ,  $p'_y > \bar{p}_y$ ,  $n'_y > \bar{n}_y$ .

Proof: Since  $H_{xy} \equiv 0$ ,  $H_{yy} < 0$ , and  $Q'_y > \bar{Q}_y$ , then  $H_y < AC'(y) \forall y \geq \bar{y}$ . Therefore, from (8)  $y' < \bar{y}$ . (7) then implies  $p'_y > \bar{p}_y$ , while  $n'_y > \bar{n}_y$  follows from the fact that  $Q'_y > \bar{Q}_y$ ,  $y' < \bar{y}$ .

For the X industry, suppose  $x' > \bar{x}$ . Then (7) would imply that  $p'_x < \bar{p}_x$ . Since, however,  $p'_y > \bar{p}_y$  while  $Q'_y > \bar{Q}_y$ , this is clearly impossible. Therefore  $x' < \bar{x}$ ,  $p'_x > \bar{p}_x$ .

□

Thus, as with the specific subsidy, the ad valorem subsidy leads to inefficient entry into the X industry, causing higher home country prices for X and lower individual firm outputs of x. This result, again, is true for arbitrary U-shaped average cost curves and demand systems of the form (33)-(34).

Two final points are worthy of note. First, since both the market and individual firm output results in Propositions 6 and 7 arise simply from the fact that the subsidy makes the market demand curve steeper relative to the average cost curve, the same results would be produced by an arbitrary ad valorem production subsidy. The only difference would be that the subsidy could result in a reduction in the price of X in both countries rather than only in the foreign country (as is the case with the export subsidy). It would still lead, however, to inefficient entry into the X industry and reduced firm output.

Second, the above analysis could also be employed to deal with the case of a home country ad valorem tariff. To do this, one need only suppose that, with free trade, demand is defined by the system

$$(41) \quad p_x = \Gamma(Q_x, Q_y)$$

$$(42) \quad p_y = \Lambda(Q_x, Q_y)$$

and that the tariff results in a producer price function

$$(42') \quad p_y = H(Q_x, Q_y).$$

Then, one need only interchange  $x$  and  $y$  in Propositions 6 and 7 and reverse inequality signs. One implication of this is that the tariff can lead to inefficient entry and reduced firm output of  $X$ . The welfare implications of this and other previous results are discussed in the following section.

#### 4. Welfare Analysis

Typically, a welfare analysis of this sort of problem would examine both the question of free trade versus autarky and the question of free trade versus restricted/subsidized trade. With respect to the former question, it is now well known that a sufficient condition for gains from trade is that domestic IRS/IC firms respond to trade by increasing their outputs (Markusen and Melvin (1981, 1984), Helpman (1983), Markusen (1981)). It is, therefore, easy to see that, for the range of functional forms examined in this paper, such a "rationalization" condition is always satisfied. The model thus exhibits a robust gains-from-trade property.

On the other hand, the effects of trade restrictions/subsidies with IRS, IC are less well understood and require a more thorough analysis. In what follows, the model of Section 2 will be referred to as the "linear case", and the generalizations of Section 3 as the "concave case".

The basic structure of the previous sections is retained, and domestic welfare is given by the utility function

$$(43) \quad U = U(C_x, C_y, C_z)$$

Differentiating (43) and expressing welfare in terms of  $C_z$ , we have

$$(44) \quad dW = \frac{dU}{U_z} = dC_z + \frac{U_x}{U_z} dC_x + \frac{U_y}{U_z} dC_y = dC_z + p_x dC_x + p_y dC_y.$$

In our one factor model, the production constraint is given by

$$(45) \quad \bar{L} - Z - (AC_x)X = 0$$

$$(46) \quad dZ + (AC_x)dX + Xd(AC_x) = dZ + p_dX + Xdp_x = 0$$

since  $p_x = AC_x$ .

Let excess supplies of Z and X be given by  $E_z = (Z - C_z)$  and  $E_x = (X - C_x)$ .

The balance of payments constraint is given by

$$(47) \quad E_z + p_x^* E_x - p_y^* C_y = 0.$$

$$(48) \quad dE_z + p_x^* dE_x + E_x dp_x^* - p_y^* dC_y - C_y dp_y^* = 0.$$

from (46) and (48), (44) becomes

$$(49) \quad dW = -X dp_x + (p_x^* - p_x) dE_x + E_x dp_x^* + (p_y - p_y^*) dC_y - C_y dp_y^*.$$

Now let us consider the effects of instituting arbitrarily small taxes so that  $(p_x^* - p_x) = (p_y - p_y^*) = 0$  locally. In the case of a home country import tariff, we have  $dp_x = dp_x^*$ . Noting also that  $(-X + E_x) = (-C_x)$ , (49) becomes

$$(50) \quad dW = -C_x dp_x - C_y dp_y^*$$

For the linear demand case, we noted in Section 2 that the home tariff on Y results in  $dp_x = 0$ ,  $dp_y^* < 0$ . The small import tariff thus forces down the price of the import Y, unambiguously improving domestic welfare. This result is however weakened when, with concave demand, inefficient domestic entry leads to  $dx < 0$  and  $dp_x > 0$ . The first term in (50) contributes negatively to welfare and even a small import tariff may reduce welfare.

Now consider the effects of an export tax or subsidy.  $dp_x$  and  $dp_x^*$  are no longer equal, so the welfare differential from (49) is given by

$$(51) \quad dW = -X dp_x + E_x dp_x^* - C_y dp_y^*$$

For the case of linear demand, we showed that an export tax results in  $dp_x < 0$ ,  $dp_x^* > 0$ , and  $dp_y^* = 0$ . A small export tax thus unambiguously improves welfare. An export subsidy reverses the price effects and unambiguously reduces welfare.

With concave demand, we continue to have the favorable effect  $dp_x < 0$  for the export tax in all cases. Since  $p_x^* = p_x(1+T)$ , we have

$$(52) \quad dp_x^* = dp_x(1+T) + p_x dT = dp_x + p_x dT$$

in the neighborhood of  $T=0$ . Substituting (52) into (51), we have

$$(53) \quad dW = -Xd p_x + E_x (dp_x + p_x dT) - C_y dp_y^* = -C_x dp_x + p_x E_x dT - C_y dp_y^* .$$

In the concave case, the first two terms are positive for a tax (the second term is export tax revenue) and negative for an export subsidy. However, inefficient entry in the foreign country causes  $dp_y^* > 0$  thus weakening the case for the export tariff.

Production subsidies require us to use the left-hand side of (46) since domestic price and average cost are not the same. For a production subsidy, equation (49) becomes

$$(54) \quad dW = -Xd(AC_x) - dE_z + (p_x - AC_x)dX - p_x dE_x + p_y dC_y .$$

Substituting for  $dE_z$  from (48) and noting that  $p_x = p_x^*$  and  $p_y = p_y^*$ , equation (54) becomes

$$(55) \quad dW = -Xd(AC_x) + E_x dp_x^* + (p_x - AC_x)dX - C_y dp_y^* .$$

In the neighborhood of a zero subsidy,  $p_x = AC_x$  and (55) is locally equal to

$$(56) \quad dW = -Xd(AC_x) + E_x dp_x^* - C_y dp_y^* .$$

In the linear case, each of the three terms is either zero or acts to reduce welfare. With respect to the first term, the advalorem and capital subsidies increase average cost, while the specific subsidy leaves it unchanged.  $dp_y^*$  equals zero while  $dp_x^* < 0$ . All three forms of production subsidy lead to a terms of trade deterioration with the advalorem and capital subsidies leading to inefficient entry and rising average cost as well. Strictly concave demand weakens this strong result only to the extent that a subsidy generally forces the Y industry to rationalize, leading to a favorable terms-of-trade effect  $dp_y^* < 0$ .

The last point to consider is the effect of a tariff or subsidy large enough to drive out or prevent entry of the Y industry. With homogeneous goods, we noted that any arbitrarily small tariff or subsidy drives out Y. In the case of a tariff with concave demand, there is no change in the output per firm in the X industry, and entry occurs until the lost output from Y is exactly offset. Production merely shifts to the home country and there is no change in consumer welfare in either country. With either an export or a production subsidy, however, welfare unambiguously deteriorates. Subsidy payments must actually be made (as opposed to the tariff where no revenue is actually collected) and in most cases inefficient entry raises the average cost of production (strictly concave demand, or linear demand with an advalorem or capital subsidy). In the case of homogeneous goods, free trade is therefore optimal.

## 5. Summary and Conclusions

(1) Recent papers on scale economics, imperfect competition and trade have, in addition to their scientific interest, attracted attention because of their relevance to the "new protectionism". Among other results, these papers produce situations in which an export subsidy or a production subsidy to domestic firms improves domestic welfare. These subsidies, which are never optimal in traditional trade theory, have the beneficial effects of reducing the average cost of domestic firms and/or transferring to the domestic economy the monopoly rents of foreign firms (e.g., Brander and Spencer (1981), Spencer and Brander (1983), Krugman (1984)). A positive role for tariffs and subsidies is also obtained by Venables (1985), by assuming free entry, but allowing firms to price discriminate between domestic and foreign markets.<sup>11</sup> The ability to price discriminate means that, as in the no-entry case, there is no direct link between price and average cost in individual markets. This paper has addressed the same policy issues dealt with by these authors, but allows free entry and

no price discrimination. Retaining most of their other general assumptions, we showed that the case for subsidies disappears entirely and the case for an import tariff generally reverts to the usual terms-of-trade argument.

(2) In the two country model, each country produces one good with increasing returns, the goods being either perfect or imperfect substitutes. Firms behave in a Cournot fashion and free entry drives profits to zero. Provided that (A) demand is concave (linear or strictly concave) and independent for the two goods, and (B) average cost is u-shaped, free trade will lead firms to expand output relative to autarky thereby guaranteeing gains from trade. Identical cost functions and/or country sizes are not necessary for this result, although if the goods are good substitutes, then a sufficient cost disadvantage will lead to the elimination of the domestic industry. But even this outcome has no adverse welfare implications since no rents are being earned and since the costly domestic good is replaced by a cheaper, symmetric foreign substitute. The free entry assumption thus rules out certain perverse outcomes that have been pointed out by Markusen and Melvin (1981, 1984), Helpman (1983), Markusen (1981), and Helpman and Krugman (1984).

(3) Again assuming concave demand, it was shown that either an export subsidy or a production subsidy leads to inefficient entry that results in an increased or at best an unchanged level of domestic average cost and price. Although total domestic output generally expands, the industry does not rationalize and thus does not capture the same gains which accrue in the no-entry case. Further, no foreign monopoly rents are captured because there are none. The only possible gain from such subsidies is that the foreign industry is forced to rationalize, thus leading to a lower price for the foreign import. This



latter effect does not occur with linear demand, thus providing one simple case where the subsidies unambiguously reduce welfare. Conversely, a small export tax improves welfare by improving the country's terms of trade in the usual sense and by forcing the domestic industry to rationalize.

(4) The case of an import tariff is somewhat more complicated. A tariff forces the foreign industry to rationalize, leading to a fall in the price of the foreign good. The foreign industry loses sales and market share in the domestic market but gains sales in its own market. The opposite occurs for the home industry. The fall in the price of the foreign good constitutes a benefit to the domestic economy. But this is nothing other than the usual beneficial terms-of-trade effect of a tariff. On the other hand, the tariff causes inefficient domestic entry and rising average costs in that industry for a wide range of functional forms. This second effect thus weakens the traditional (terms-of-trade) argument for a tariff, but does not of course imply that a small tariff reduces welfare. Indeed, it is possible to find functional forms that reverse this second effect as we showed in the linear example of Section 2, where the tariff had no effect on domestic output per firm.

(5) It was shown that free trade is superior to a tariff or a subsidy large enough to drive out (prevent the entry of) the foreign industry. The best outcome seems to be that the latter leaves domestic welfare identical to the free trade level (goods are perfect substitutes and an import tariff is the instrument). If goods are imperfect substitutes and/or a subsidy is used, the policy necessarily reduces welfare.<sup>12</sup> Since any positive tariff or subsidy drives out the foreign industry when the goods are perfect substitutes, free trade is therefore optimal in that special case.

(6) It might be argued that all we have done here is produce another special model with special assumptions leading to special results. However, we would argue that our model and results are of considerable policy importance. First, we believe that there is a wide-spread fear (whether justified or not) that some governments are seriously considering expensive or protectionist industrial strategies. Since the welfare consequences are not trivial, we believe that the burden of proof should be on those who advocate the use of subsidies or tariffs to gain strategic advantages for domestic firms. Second, as noted in the Introduction, the theoretical models produced to date by trade economists imply beneficial effects from tariffs and subsidies (Eaton and Grossman (1983) is an exception). Thus most current IRS/IC models support the interventionist cause. If nothing else, this paper shows that these models are not robust and that a simple alternative formulation produces opposite results. Finally, as also noted in the Introduction, the predictions of our model seem to be closely consistent with extensive Canadian data on the effects of trade liberalization. While one could probably produce some cases that support the use of no-entry oligopoly models, we know of no broadly based data set that supports such an assumption.

Footnotes

<sup>1</sup>Venables' assumption that firms can price discriminate is the crucial difference between his model and the model in this paper, in that it is this assumption which leads to the disparity in results. That the ability (or inability) to price discriminate should have this effect should not be surprising. One need only consider a simple monopoly situation to understand the problem. If a monopolist cannot price discriminate, then it is well-known that a production subsidy is welfare improving. If the monopolist can price discriminate, and does so by two-part pricing, then the same subsidy would be welfare reducing.

<sup>2</sup>Baldwin and Gorecki use a comprehensive Statistics Canada data set containing firm-level data on 167 manufacturing industries producing some 6,000 products.

<sup>3</sup>Autarky outputs would be given by  $x = (LF_x/\beta)^{\frac{1}{2}}$  and  $y = (L^*F_y/\beta)^{\frac{1}{2}}$ , respectively.

<sup>4</sup>This gains-from-trade result is similar to those derived in the other papers listed above (e.g., Venables) and so we will not dwell upon it. The principal differences arise in the analysis of tariffs and subsidies.

<sup>5</sup>The strict concavity simplifies proofs and focuses consideration on cases not described by the model of the previous section. It also is useful for dealing with the question of existence of a Cournot equilibrium. See footnote 7.

<sup>6</sup>Essentially, this requires that minimum efficient scale not be too large relative to market demand. For a detailed discussion of this problem in the homogeneous good case, see Novshek (1980).

<sup>7</sup>The issue of existence of equilibrium is not dealt with here.

Obviously, as long as costs are not too convex, the assumption of concave demand will be sufficient to guarantee existence of a Cournot equilibrium.

<sup>8</sup>It should be noted that, while concavity of demand simplifies the proof of Proposition 3, the result could still be obtained were demand convex. In this case, it would simply have to be that demand is not sufficiently convex as to make existence an issue. Given this, however, one need only note that at  $\bar{x} = y^*$  marginal revenue is greater than marginal cost and then exploit second-order conditions to obtain the desired result.

<sup>9</sup>Note that while  $H(\cdot)$  is defined as before, the fact that demand in the home and foreign country differs only by the size factor  $\lambda$  is never exploited here. Therefore, these results would hold for arbitrary demand specifications across countries.

<sup>10</sup>An example of the former case is the linear model of Section 2. The latter would occur were demand as in (33)-(34) and  $AC'' = 0$  for some range of  $x$  in the neighborhood of equilibrium.

<sup>11</sup>To see the difference which this assumption makes, consider the case of the home country export subsidy. In either case, this subsidy allows home country firms to compete more effectively abroad. With no price discrimination, however, a home country firm must consider the effect of lower foreign prices on the price (and profits) of its domestic product. This is not a problem if the firm can price discriminate. Further, should inefficient entry occur due to expanded profit opportunities, equivalent price changes must occur in both the home and foreign country with no price discrimination. With price discrimination, the problem of inefficient entry is mitigated since foreign (subsidized) prices

can be raised more rapidly than prices in the home country. Thus, the subsidy may actually lead to more output and lower prices than prevailed previously.

<sup>12</sup>We have not taken the space needed to show that a prohibitive tariff is welfare reducing when X and Y are imperfect substitutes, but it is straightforward to do so with the algebra of Section 4. Intuitively, eliminating imported Y costs the domestic economy consumer's surplus without reducing the price of X.

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